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The correlation between scores in selected eighth grade tests and achievement in ninth grade algebra

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THE CORRELATION BETWEEN SCORES IN SELECTED EIGHTH GRADE TESTS AND ACHIEVEMENT IN NINTH GRADE ALGEBRA

A Thesis

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by

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CHAPTER I

INTRODUCTION

Statement of the Problem. This study was concerned with algebra readiness. The policy of the Stockton Unified School District, where the study was made, was to schedule students to take elementary algebra in grade nine if their test scores indicated a reasonable expectancy of success. The problem was to determine which of the group test scores available at the end of grade eight would best predict success in first-year algebra.

Need to Determine Algebra Readiness. Determining which students should be scheduled to take elementary algebra requires administrative decision. An objective basis for judging algebra readiness may be expected to make possible a more consistent discrimination between those who should and those who should not be scheduled to take it. If the results of tests already scheduled to be given for evaluating achievement can also be used for placement discrimination, savings of pupil time and energy and of administrative time and money will be effected.

An objective basis for determining algebra readiness could also be valuable in counseling. Objective data could be used to interpret the administrative decision to the pupil and

his parents, or as a basis for arriving at a decision cooperatively.

The Thesis. The thesis was that those group test results available in grade eight which had the highest correlation with success in elementary algebra might be used to anticipate degree of success in algebra and thus to discriminate which students should be scheduled to take algebra the following year. Since several specific scores were available, the purpose of the study was to determine which of them or what combination of them should be used in making the decision as to which students should take algebra. A single score might prove to be the best predictive factor, or a formula involving more than one score might be used if it would yield a significantly better prognosis than the best single-item predictive factor.

Action Research Study. This study was specifically related to the Stockton Unified School District.[1] Using the action research approach, which Corey focused specifically on educational practices,[2] it was expected that the findings would be applied primarily in the same schools and with the same

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[1]Hereafter also referred to as SUSD and as the District.

[2]Stephen Corey, Action Research to Improve School Practices (New York: Bureau of Publications, Teachers College, Columbia University, 1953), 161 pp.

population characteristics that obtained as the study was being made. The student population of the SUSD in the year of the study was taken not as a sample of a larger population, but rather as a sample of the population of the same school system over a span of years beginning with the year of the study.

Traditional Practices. A general statement of the policy concerning algebra readiness in the Stockton Unified School District in years past would be that a student in order to be scheduled to take algebra in grade nine should test with a grade placement score up to the average expectancy for his grade in grade eight. Since the standard tests were administered during the spring semester, an arithmetic score of 8.5 grade placement was used as an approximate basis for discrimination as to which students should be scheduled to take algebra. Other factors were also used as a basis for judgment when the arithmetic score was close to 8.5, including IQ scores,[3] reading scores, previous grades, and teachers' recommendations.

The adequacy of this policy was augmented by the experience of those administering it, and by the further policy of somewhat greater freedom in allowing students desiring to take

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[3]IQ = intelligence quotient, i.e., mental age / chronological age x 100.

algebra to take it in grade ten after an additional year of arithmetic in grade nine. The tests used principally prior to 1954 were the Stanford Arithmetic[4] and the California Arithmetic[5] tests.

Changes of Situation. Among the changes which tended to make these established procedures less adequate was the growth of the district. Two decades ago there was but one secondary school in Stockton, Stockton High School. In 1959 there were three senior high schools and four junior high schools and others were in the planning stage. This meant that several people were involved in implementing established policies, so that the rather tenuous consideration of factors other than the primary one of arithmetic achievement was subject to various interpretation.

Another change was in the organizational pattern of the district. The 6-4-4 pattern, used from 1948 to 1956, was replaced by the 6-3-3-2 pattern, with six years in elementary schools, three years each in junior and senior high schools, and two years in junior college.

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[4]Truman L. Kelley, et al. Stanford Achievement Test, Advanced Form JM (Chicago, Ill.: World Book Encyclopedia, Field Enterprises).

[5]Ernest W. Tiegs and Willis W. Clark, California Arithmetic Test (Los Angeles: California Test Bureau, 1950), Intermediate Forms AA, BB, or CC.

A change in the testing program followed this change in organizational pattern. "Status tests," as the term is used in the Stockton Unified School District, refers to those tests administered by the District for purposes of record and of critical analysis. Having been administered in alternate years, they were re-scheduled, to be given instead in grades six, nine, and twelve, at the completion of the successive segments in the new organizational pattern. Sequential Tests of Educational Progress were adopted for these status tests.[6] For the intervening years, Iowa Tests of Basic Skills were recommended following studies made under the leadership of the Research Department of the District.[7] Since the results of the Iowa Tests of Basic Skills and of the California Test of Mental Maturity would be the ones available for grades seven and eight in subsequent years, they were the ones used in this study.

Nature of Study. Two groups of objective data were required for this study: the predictive scores, to be available before students took algebra, and criterion scores, to be available after the year's instruction in algebra was completed, for evaluating algebra success. Group test scores

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[6] Sequential Tests of Educational Progress (Princeton, N. J.: Educational Testing Service, 1957, 1958).

[7] Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1955, 1956).

available before the students took algebra were three California Test of Mental Maturity[8] scores: total IQ, language IQ, and non-language IQ, and three Iowa Tests of Basic Skills scores: arithmetic concepts, arithmetic problem solving, and reading comprehension. The objective test used as a criterion of algebra success was the Lankton Algebra Achievement Test.[9] Product-moment correlations between the six predictive factors, three CTMM scores and three Iowa Tests scores, and the Lankton Algebra Achievement Test were computed and analyzed, for each of the junior high schools and for the Stockton Unified School District as a whole.

Brief Summary of Findings. For the district as a whole, the scores which best predicted algebra success were found to be the total IQ score and the Iowa Arithmetic Concepts score. The total IQ score was first by a small margin for the total sampling, but the Iowa Arithmetic Concepts score was the first ranking item in three of the four junior high schools.

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[8]California Short-Form Test of Mental Maturity (Los Angeles: California Test Bureau, 1951).

[9]Lankton First-Year Algebra Test, Evaluation and Adjustment Series, (Chicago: World Book Company, 1951).

CHAPTER II

CONTRIBUTIONS AND LIMITATIONS OF PREVIOUS STUDIES

Contributions of Previous Studies. Previous studies have adequately confirmed a significant correlation between eighth grade test scores and success in ninth grade algebra. Brown summarized, "Research has shown that a combination of scores on an aptitude test and an achievement test, and previous mathematics marks is a good predictor of success in high school mathematics."[1] Studies have not agreed as to which of the various predictive factors best indicates algebra readiness. The best predictive factors have been variously found to be (1) prognostic tests, (2) arithmetic grades, and (3) specifically identified arithmetic tests.

In several of the earlier studies, prognostic tests were found to correlate significantly with algebra success. A study by Grover in 1932 indicated that the Orleans Prognostic Test was valuable in indicating algebra readiness.[2] A study

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[1] Kenneth E. Brown, Analysis of Research in the Teaching of Mathematics 1955 and 1956, United States Department of Health, Education, and Welfare Bulletin 1958 #4 (Washington: Government Printing Office, 1958), p. 22.

[2] C. C. Grover, "Results of Experiment in Predicting Success in First Year Algebra in Two Oakland Junior High Schools," Journal of Educational Psychology, 23:309-14, April, 1932.

by Orleans in 1934 indicated that an algebra prognosis test had a higher predictive value of algebra success than either IQ or 8th grade arithmetic scores.[3] In 1944 and 1947 studies by Guiler[4] and Grime[5] validated the Iowa Algebra Aptitude Test. The Grime study, involving 2615 pupils of the Cleveland public schools, reported a correlation range of .68 to .70 between the Iowa Algebra Aptitude Test and success in first and second semester algebra.

Grades earned in previous arithmetic courses were reported as the best predictive factor by Layton in 1941[6] and by McMillan in 1956.[7] Layton reported that arithmetic grades showed the highest correlation with both measures of achievement, algebra grades (.82), and achievement test scores on a standard algebra test (.68). Other scores considered by Layton as predictive factors were the Lee Test of Algebra

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[3]Joseph B. Orleans, "A Study of Probable Success in Algebra and Geometry," Mathematics Teacher, 27:225-46, May, 1934.

[4]W. S. Guiler, "Forecasting Achievement in Elementary Algebra," Journal of Educational Research, 38:25-33, September, 1944.

[5]Herschel E. Grime, "Aptitude and Ability in Elementary Algebra," School Science and Mathematics, 47:781-4, December, 1947.

[6]R. B. Layton, "A Study of Prognosis in High School Algebra," Journal of Educational Research, 34:603, April, 1941.

[7]LaVerne Ruth McMillan, "A Comparative Study of the Prediction of Achievement in Ninth Grade Algebra," (unpublished Master of Arts thesis, University of Texas, 1956).

Ability, the Stanford Arithmetic Test, and the Otis Self-Administering Test of Mental Ability. In addition to eighth grade arithmetic marks, McMillan considered the Lee Test of Algebra Ability, the California Arithmetic Test, and the Detroit Alpha Intelligence Test as predictive tests. She found that marks in eighth grade arithmetic best predicted success in elementary algebra.

Results of specific arithmetic tests were found to be the best predictors of success in algebra by Dickter in 1933[8] and Kuehn in 1955.[9] Dickter found that the Rogers Test of Mathematical Ability correlated higher (.65) with algebra achievement than either eighth grade arithmetic marks (.61) or Otis IQ scores (.54). Kuehn found that the Seattle arithmetic test, used alone, was almost as good a predictor of success in algebra as any combination of the variables. Other predictive variables considered were the California Reading test, the Stanford Achievement test (computation), and the SRA Test of Primary Mental Abilities.

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[8]M. Richard Dickter, "Predicting Algebra Ability," School Review, 41:605, October, 1933.

[9]Henry John Kuehn, "An Evaluation of a Test of Primary Mental Abilities, Two Tests of Arithmetic Achievement, and a Test of Reading Ability as Predictors of Success on a Test in Elementary Algebra," (unpublished Master of Education thesis, University of Washington, 1955).

Whitesel in 1956[10] compared a widely diversified number of factors as items for predicting success in algebra. The following variables were studied on 170 cases: (1) screening test scores, (2) eighth grade total grade points, (3) IQ scores, (4) reading vocabulary scores, (5) reading comprehension scores, and (6) days present. He found that the screening test was the best variable for predicting success in algebra.

Limitations of Previous Studies. Adequate evaluations were not available for the tests used in the basic testing program of the Stockton Unified School District, the California Test of Mental Maturity and the Iowa Tests of Basic Skills.

These two tests yield several scores. The California Test of Mental Maturity yields three scores, the language, the non-language, and the total IQ. Of the Iowa Tests of Basic Skills, the reading comprehension score was considered as a possible predictive item in addition to the two arithmetic scores. One arithmetic test was concerned with problem solving; the other, the arithmetic concepts test, related specifically to arithmetic meanings and understandings. The arithmetic concepts score which might reasonably be expected to have a

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[10]William Frank Whitesel, "A Study to Predict Success in Algebra of Ninth Grade Students in the Puyallup Junior High School," (unpublished Master of Education thesis, University of Washington, 1956).

high predictive value for algebra success, was not included as a discrete item in any of the previous studies.

Relating the previous studies to the present one, they indicated that the test scores being considered in this study should predict algebra success, but that further research was needed to make the best interpretation and use of the results.

CHAPTER III

INSTRUMENTS OF EVALUATION

For this study the predictive instruments were tests of the California Test of Mental Maturity and the Iowa Tests of Basic Skills. The criterion instrument was the Lankton First-Year Algebra Test.

California Test of Mental Maturity. The California Test of Mental Maturity was used by the Stockton Unified School District as the group intelligence test.[1] Important in the selection of a group intelligence test is its concurrent validity. "Concurrent validity is evaluated by showing how well test scores correspond to measures of concurrent criterion performance or status."[2] Consistently high correlations between the CTMM and the Stanford-Binet have been reported by the publishers of the test, such as the correlation of 0.88 reported concerning the Los Angeles County Schools.[3] "Validity of the CTMM is further attested by its

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[1]Elizabeth T. Sullivan et al, California Short-Form Test of Mental Maturity, (Los Angeles: California Test Bureau, 1957). Also referred to by its initials, CTMM.

[2]American Psychological Association, Technical Recommendations for Psychological Tests and Diagnostic Techniques, (Washington: American Psychological Association, 1954), p. 14.

[3]Elizabeth T. Sullivan et al, Manual: California Short-Form Test of Mental Maturity, (Los Angeles: California Test Bureau, 1957), p. 6.

high correlation with the Wechsler-Bellevue and Wechsler Intelligence Scale for Children (WISC)."[4] As to its reliability, an analysis of the standard errors of measurement indicate that "chances are two to one that (the examinee's) IQ will not vary more than 6.4 points and nineteen to one that it will not vary more than 12.8 points from his true IQ."[5]

Other factors necessarily considered by the SUSD in choosing a group intelligence test were ease of administering, length, adaptability to the school schedule, availability of machine scoring, comprehensiveness of span of grades for which it was available, and adequacy of articulation between the various tests included in the range.

On the basis of considerations such as these the CTMM was chosen by the SUSD research department as the IQ test to be used for status testing in the district. Since a CTMM score would be available for each student whose schedule was being made for the following year, CTMM scores were included as scores to be evaluated for predicting algebra success.

Iowa Tests of Basic Skills.[6] The selection of an arithmetic test by the SUSD was largely on the basis of its

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[4] Ibid.

[5] Ibid., p. 4.

[6] Iowa Tests of Basic Skills, (Boston: Houghton, Mifflin Company, 1956).

content validity. "Content validity is evaluated by showing how well the content of the test samples--subject matter about which conclusions are to be drawn."[7] An evaluation of available arithmetic tests was made under the leadership of the SUSD Research Department, by the Directors of Curriculum and Guidance of the various schools, and through them, by the mathematics teachers. Beyond the basic practical considerations such as total time required, adaptability to school schedules, and availability of machine scoring, the essential question was which of the available tests would best show whether the students had learned what they should have learned in their arithmetic instruction. The Arithmetic Problem Solving test of the Iowa battery required that the student interpret a situation understandable to him and decide what operations were necessary rather than merely to find answers to formulated algorism. In the Arithmetic Concepts test, "the emphasis is on understanding of the number system, of terms, processes, and operations, and of units of measurement."[8]

Sequential Tests of Educational Progress.[9] The test battery adopted for district-wide use at the end of grades six,

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[7]American Psychological Association, op. cit., p. 13.

[8]Manual: Iowa Tests of Basic Skills, (Boston: Houghton, Mifflin Company, 1956), p. 69.

[9]Sequential Tests of Educational Progress, (Los Angeles: Educational Testing Service, 1957, 1958.)

nine, and twelve is the STEP battery, the Sequential Tests of Educational Progress. This releases the Iowa battery for use in grades seven and eight, the grades with which this study is concerned.

Lankton Algebra Test.[10] The choice of the algebra test to be used at the end of grade nine for an objective measure of success in first-year algebra was also by content validation, by submitting the various available tests to the teachers of the district, for them to select the one which best covered the material being taught in the course. Samples of the various first-year algebra tests were distributed to all ninth grade algebra teachers in the District by the mathematics committee. Their concensus was that the Lankton Test was the best of those examined.

Statistical Terminology Used. Statistical terms were used with their usual meanings.

The coefficient of correlation used was the Pearson product-moment coefficient of correlation, symbolized by "r." "It is equal to the ratio of the mean of the products of the paired deviations for the two variables correlated to the product of their respective standard deviations."[11]

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[10]Robert Lankton, Lankton First-Year Algebra Test, (Chicago: World Book Company, 1951).

[11]John Gray Peatman, Descriptive and Sampling Statistics, (New York: Harper and Brothers, 1947), p. 197.

The regression line is a graph of the line whose slope is r when standard measures are used.[12] It indicates the most likely dependent variable scores as a function of the independent variable scores.

The standard deviation of the dependent variable from the line of most likely values, the regression line, is called the standard error of estimate. It is the function of the degree of co-variability between the two variables. The standard error of estimate is equal to the product of the standard deviation of the whole sample and the coefficient of alienation.[13] The coefficient of alienation, "k," "is always less than 1.00 and gives us an estimate of the reduction in errors of prediction from knowledge of correlated measurements as compared to errors of prediction without that knowledge."[14] "Whereas r indicates the strength of relationship, the coefficient of correlation, k, indicates the degree of lack of relationship."[15] "The relation of k to r is the same as that of the line of an angle to the cosine of that angle."[16] The

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[12] Joy P. Guilford, Fundamental Statistics in Psychology and Education, (New York: McGraw-Hill Book Company, 1950), p. 370.

[13] Peatman, op. cit., pp. 450-62.

[14] Guilford, op. cit., p. 373.

[15] Ibid., p. 377.

[16] Ibid., p. 376.

index of forecasting (or predictive) efficiency, "E," an indication of the reduction of the margin of error, "is defined as the percentage reduction in errors of prediction by reason of correlation between two variables."[17]

Units for Expressing Results. Of the several established units for expressing test results, three have been used in this study, centile (or percentile), grade placement, and stanine.

A centile point or score is a value on the scoring scale below which are any given percentage of the cases.[17]

The grade placement score is an indication of the score that would have been obtained by an average student of the indicated grade in school.

The stanine score is obtained by dividing a standard score into a nine-unit range.[18] The mean of 5 and the standard deviation of approximately 2, with each stanine including .5 of a standard deviation, involves contractions at the tails of the curve. The rare one person in a hundred at either extreme is submerged with the other 3 per cent next to him,[19] to make an expectancy of 4 per cent in stanines one and nine.

As used in the Stockton Unified School District, the stanine pattern has an additional refinement. If a given score

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[17] Ibid., p. 107. [18] Ibid., p. 503. [19] Ibid.

is near the dividing line between staninos, so that a score on a re-test might fall in an adjoining stanine, both likely scores are given. With the doubtful area between stanine bands thus indicated, the chances are two out of three that in a re-test a student's score would be the same.

CHAPTER IV

PRESENTATION OF THE DATA

Scores and Test Results Available. The sequence of events which made possible the securing of the test scores for this study was fortuitous. All tests whose scores were used as predictive instruments were administered as a part of the district testing program. The Iowa Tests of Basic Skills and the California Test of Mental Maturity were administered to all eighth grade students in the Stockton Unified School District in the spring of 1957. The Lankton First Year Algebra Test was administered to all ninth grade students in the district who completed elementary algebra in the spring of 1958. All for whom all of these test scores were available were included in the study, a total of 422 students in four junior high schools. This was the last year district-wide status tests were administered in grade eight; the following year the new policy was in effect which involved administering status tests in grade nine instead.

The study was synchronized to take advantage of test scores available as changes of test policy were being effected in the district. There was uniform, district-wide administration of tests which would be subsequently available for use in grades seven and eight. All test scores were current, whereas IQ scores would not necessarily be current in other years if

scores one or two years old were available. The change being made from Iowa Tests of Basic Skills to Sequential Tests of Educational Progress for the district testing program released the Iowa tests for use in grades seven and eight. Furthermore, during the following year, 1958-59, three eighth grade algebra classes were established in the district, which meant that the sampling would be less complete in any subsequent year, the universe of ninth grade students in the district qualified to algebra having been diminished by those who had already completed it in grade eight. The Lankton First Year Algebra Test was administered as an objective measure of algebra achievement in the spring of 1958 to take advantage of the unique availability of the eighth grade test scores.

Findings Correlated. The results of the California Test of Mental Maturity and the Iowa Tests of Basic Skills were available on IBM[1] cards, for all students who were in grade eight in the spring of 1957. In the spring of 1958, after the Lankton Algebra Test had been administered to all students in grade nine who were completing their first year of algebra, each student's algebra score was entered on the IBM card with his eighth grade scores. All students for whom the scores used in the study were available, were included in the study.

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[1]International Business Machines.

Coefficients of correlation were computed for each of the junior high schools in the Stockton Unified School District, then for the district as a whole, between each of six test scores as predictive items and the Lankton Achievement test scores as the criterion item, or measure of achievement. The six predictive scores consisted of three California Test of Mental Maturity scores, the language IQ, the non-language IQ, and the total IQ, and three Iowa Tests of Basic Skills scores, arithmetic concepts, arithmetic problem solving, and reading comprehension.

Indexes of predictive efficiency were derived from the coefficients of correlation, as shown in Table I, page 22.

Fremont Junior High School Results. There were 56 students (for whom) results were available at Fremont Junior High School. The highest ranking predictive test was the Iowa Arithmetic Concepts, with a coefficient of correlation of .642 with the Lankton Algebra test score. The CTMM language IQ score was second, with a coefficient of correlation of .561. In rank order, these were followed by Iowa Reading Comprehension (r = .446), Iowa Problem Solving (r = .416), CTMM total IQ (r = .396), and CTMM non-language IQ (r = .229).

The index of predictive efficiency of the Iowa Arithmetic Concepts score was 23.6%, while that of the CTMM language IQ score was 17.3%, and those of the other items were 10.5% or

TABLE I

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY OF SIX CALIFORNIA TEST OF MENTAL MATURITY AND IOWA TESTS OF BASIC SKILLS SCORES AS PREDICTIVE ITEMS AND LAWTON ALGEBRA TEST SCORES AS CRITERION ITEMS

	Fremont Jr. High School N = 56		Marshall Jr. High School N = 58		Stockton Jr. High School N = 142		Webster Jr. High School N = 166		District N = 422	
Correlations of Lawton Algebra Test with:	r	E	r	E	r	E	r	E	r	E
CTMM Total IQ	$.396^{5}$	8.1%	$.572^{4}$	17.9%	$.550^{2}$	16.5%	$.513^{3}$	14.2%	$.547^{1}$	16.3
Iowa Arith. Concepts	$.642^{1}$	23.5	$.767^{1}$	35.8	$.662^{1}$	25.1	$.485^{4}$	12.6	$.529^{2}$	15.1
Iowa Problem Solving	$.416^{4}$	9.0	$.610^{3}$	20.8	$.531^{3}$	15.3	$.521^{2}$	14.5	$.460^{3}$	11.2
Iowa Reading Comp.	$.446^{3}$	10.5	$.671^{2}$	25.9	$.343^{6}$	6.1	$.472^{5}$	11.8	$.445^{4}$	10.5
CTMM Language IQ	$.561^{2}$	17.3	$.513^{5}$	14.2	$.374^{5}$	6.5	$.584^{1}$	18.8	$.399^{5}$	8.3
CTMM Non-Language IQ	$.229^{6}$	2.7	$.344^{6}$	6.1	$.470^{4}$	11.7	$.234^{6}$	2.8	$.335^{6}$	5.8

r = Coefficient of Correlation
E = Index of Predictive Efficiency
Superscripts indicate rank order of items by columns

lower. The index of predictive efficiency indicates the degree to which each predictive test predicts to the criterion. It is a second degree (non-linear) function of the coefficient of correlation, so that E increases as r increases, but the rate of increase is different, as shown on Figure 1, page 24. The significance of the two top-ranking items is observed to be respectively two, and one and one-half times that of any of the other items. The Arithmetic Concepts score has two and one-half times the predictive efficiency of the other arithmetic score, Problem Solving.

The Fremont Junior High School community is largely English-speaking, but not economically favored. This may account for the fact that the CTMM language IQ and the Reading Comprehension scores are second- and third-ranking items. These language-related items might in this type of community identify those most able to comprehend concepts represented by symbols, or those with better than average language usage in the home. The number of students in the sampling from Fremont is relatively small so that care must be taken not to over-interpret the findings.

Marshall Junior High School Results. Test scores were available for 58 students from Marshall Junior High School, again a relatively small sampling. The three achievement scores ranked above the three IQ scores as predictive items,

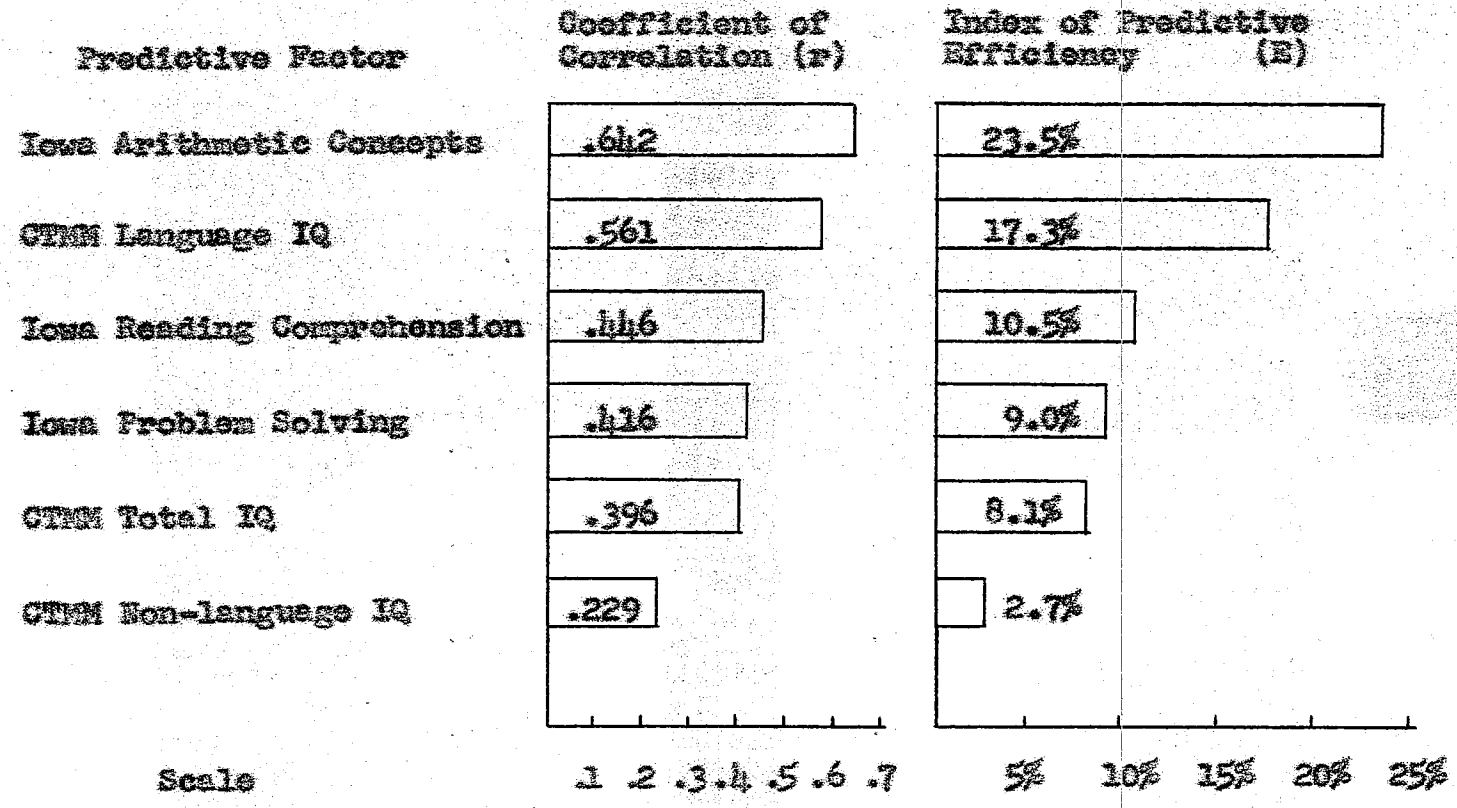


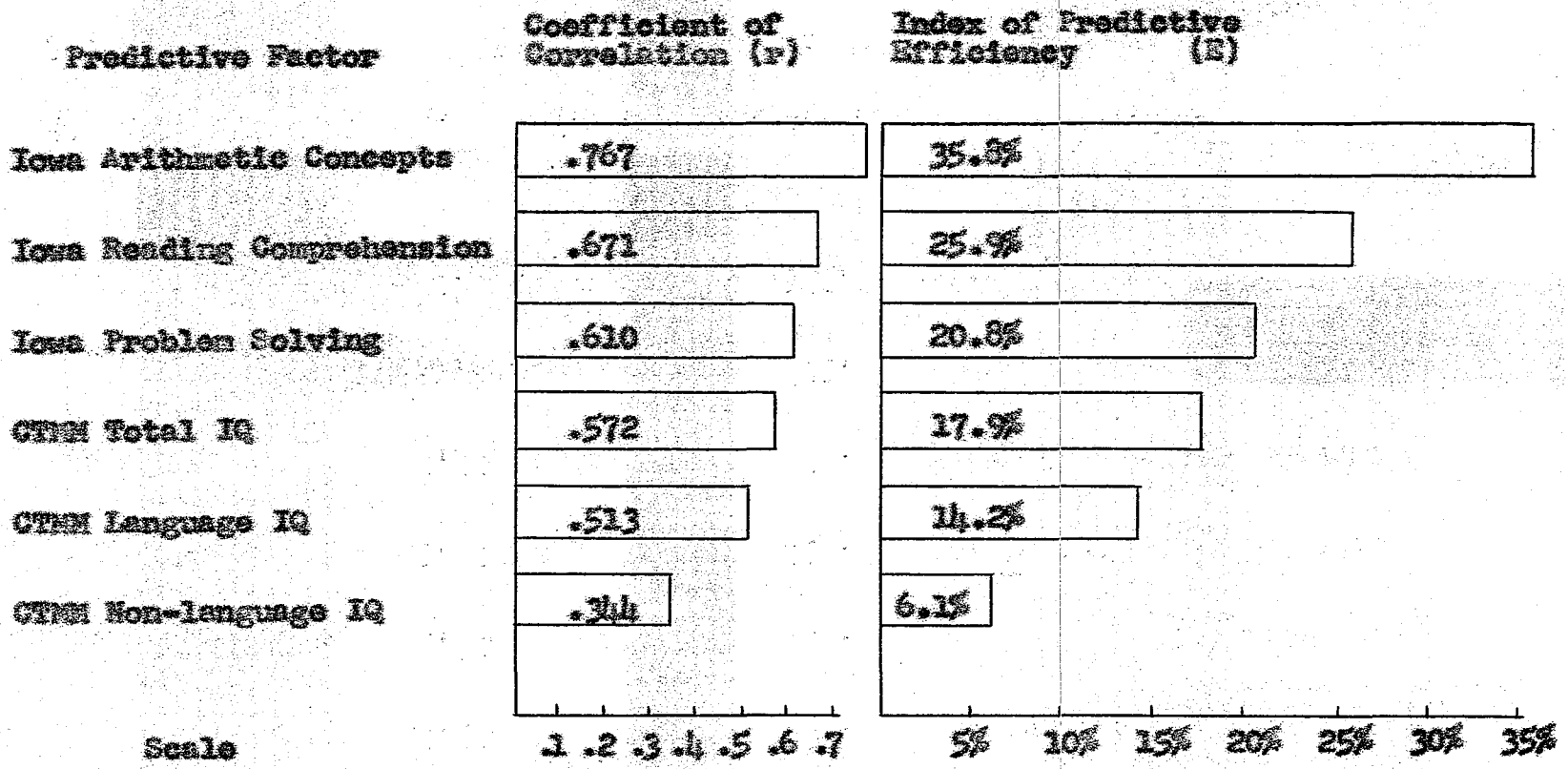
FIGURE 1

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY BETWEEN VARIOUS PREDICTIVE FACTORS AND LAWTON ALGEBRA TEST

as shown on Figure 2, page 26. The top-ranking predictive item was again the Arithmetic Concepts score, with a coefficient of correlation of .767 and a predictive efficiency of 35.6%. The second-ranking item again was language-related, this time being the Reading Comprehension score, with r = .671 and E = 25.6%. The third-, fourth-, and fifth-ranking items at Marshall Junior High School were the Iowa Problem Solving, CTMM Total IQ, and CTMM Language IQ, with Indexes of Predictive Efficiency (E) of 20.8, 17.9, and 14.2%, respectively.

Marshall Junior High School showed the highest pattern of correlation of any of the schools in the study. Its second ranking predictive item was higher than the first ranking item at any other school, and its fourth ranking item was above the second ranking item at any other school. This comparatively high correlation would indicate that these students were working more nearly to capacity than those in most samplings. The algebra teacher at Marshall confirms that this interpretation is consistent with her observation.

The Marshall Junior High School community has a larger non-white population, Negro, oriental, and Mexican, than any of the other junior high schools in the Stockton Unified School District. There are more homeowners in this area than in the Fremont area, however, and the economic status is probably somewhat better.



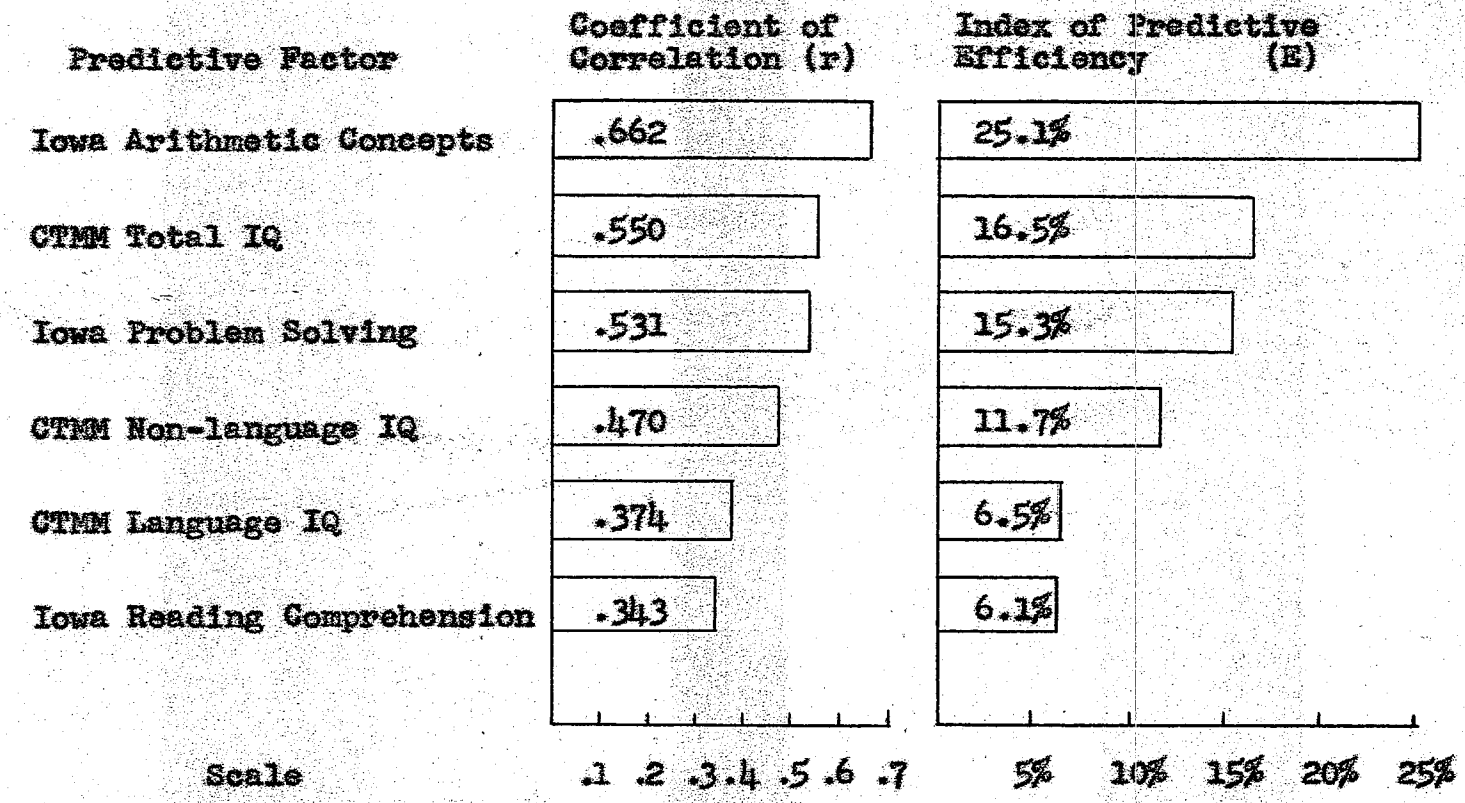
MARSHALL JUNIOR HIGH SCHOOL N = 58

FIGURE 2

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY BETWEEN VARIOUS PREDICTIVE FACTORS AND LAWTON ALGEBRA TEST

Stockton Junior High School Results. Scores were available for 142 Stockton Junior High School students. The predictive test which yielded the highest coefficient of correlation (r = .662) was again the Iowa Arithmetic Concepts. Its index of predictive efficiency, 25.1%, was slightly higher than the top predictive score at Fremont, but much lower than that at Marshall. As shown on Figure 3, page 28, the second-ranking predictive item was the CTMM total IQ score with r = .550 and E = 16.5%. The third-ranking predictive item, very close to the second, was the Iowa Problem Solving score, with r = .531 and E = 15.3%. Only at this school did the CTMM non-language IQ rank higher than sixth of the six predictive tests; here it ranked fourth, with r = .470 and E = 11.7%. The two language-related items, CTMM language IQ and Iowa Reading Comprehension, one of which ranked second in each of the two preceding schools, were fifth- and sixth-ranking items at Stockton, with r scores of .374 and .343, and E scores of 6.5 and 6.1%, respectively.

The population served by Stockton Junior High School was widely divergent not only in characteristics, but in geographical location. As the Stockton Unified School District grew and junior high schools were built in various communities, Stockton Junior High School continued to serve the areas not yet provided with new schools. The area it served was shaped somewhat like an hour-glass, extending five miles north to an



STOCKTON JUNIOR HIGH SCHOOL N = 142

FIGURE 3

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY BETWEEN VARIOUS PREDICTIVE FACTORS AND LANKTON ALGEBRA TEST

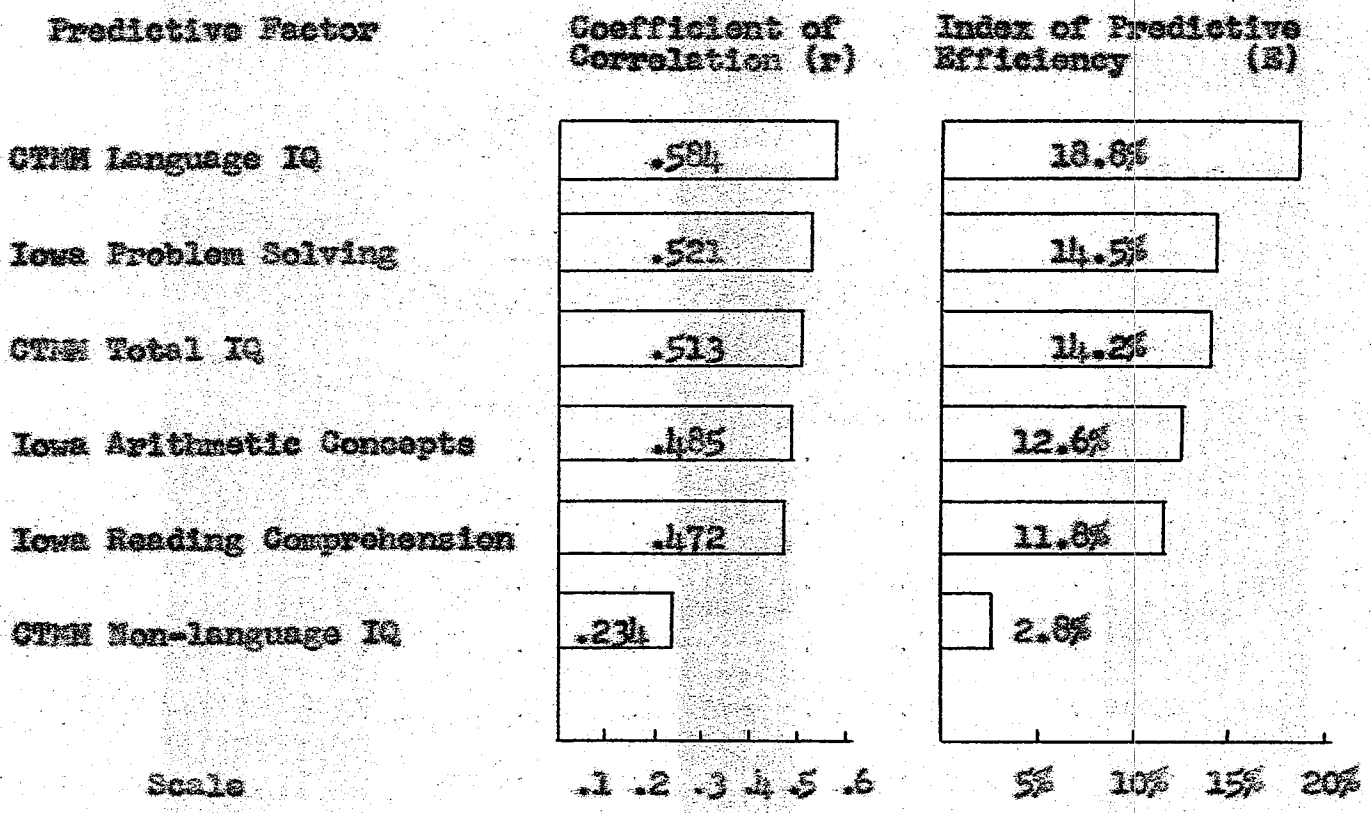
area of new and modern subdivisions, and five miles south to an area with roughly half the population colored, and dominated by a low-rent housing project. Not only was there an adjustment problem as each group was required to make associations which would not have been chosen, but there was less of a feeling of community solidarity than would have obtained in a school which was a natural community center.

This school, with its contradictory elements, was the one in the district in which the two top-ranking predictive tests were the same as in the district as a whole, and here their order was the reverse of that for the total district. Furthermore, the Arithmetic Concepts predictive efficiency (E = 25.1%) was larger than the CTMM total IQ score (E = 16.5%) in the ratio of 3 to 2. For the district as a whole, their magnitudes were about the same.

The relationship between the three IQ scores was noted. The low coefficients of correlation and indexes of predictive efficiency for the two partial IQ scores, the language and the non-language components, were in contrast with the relatively high r and E scores for the total IQ as a predictive test. A high score in either language or non-language IQ did not consistently indicate high algebra achievement, but when the composite of the two IQ scores was high, the prediction of high algebra achievement scores was appreciably increased.

Webster Junior High School Results. There were 166 Webster students for whom test results were available. The results at Webster, presented in Figure 4, page 31, showed definite contrasts to the results in the three other schools. The first-ranking predictive test in the other three schools, Iowa Arithmetic Concepts, was the fourth-ranking item at Webster, with r = .485 and E = 12.6%. The first-ranking predictive test at Webster was the CTMM language IQ with r = .584 and E = 18.8%; it was second in rank order at Fremont, but fifth at both Marshall and Stockton. The second- and third-ranking tests at Webster were the Iowa Problem Solving and the CTMM total IQ scores, with the very close scores of r = .521, E = 14.5%, and r = .513, E = 14.2%, respectively. The fifth ranking test was Iowa Reading Comprehension, with r = .584 and E = 18.8%. The CTMM non-language IQ, with r = .234 and E = 2.8%, was the sixth ranking predictive item as in all the other schools except Stockton Junior High School.

When the actual scores are compared without reference to the rank order of items, the contrast of the results is not so great. The index of predictive efficiency (E) of Webster's first ranking item was 18.8%. The E score for this same item at Fremont was 17.3% and at Marshall was 14.2%. Only at Stockton, where it was 6.5%, was it widely divergent. The second- and third-ranking tests, Iowa Problem Solving and CTMM total IQ, showed only a little lower predictive efficiency than



WEBSTER JUNIOR HIGH SCHOOL N = 166

FIGURE 4

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY BETWEEN VARIOUS PREDICTIVE FACTORS AND LANKTON ALGEBRA TEST

the same items at Stockton Junior High.

The Iowa Arithmetic Concepts scores at Webster were in contrast to those at the three other schools. At Webster, the index of predictive efficiency for this item was 12.6% and it was the fourth-ranking predictive score; at each of the other schools it was the first-ranking predictive score, with E equal to 23.5, 35.6, and 25.1 per cent, in the order of previous presentation. An analysis of the scattergram indicated a lack of homoscedasticity. At the lower end of the distribution there was a cluster of students at Webster whose scores were higher than would have been anticipated on the basis of scores on the predictive items.[2] In the higher range of achievement, both on the Arithmetic Concepts score and the Lankton Algebra score, the correlation was high. In the lower range of arithmetic scores some students made algebra scores in the average range. This may be because the Webster Junior High School is located in an area of quite uniformly middle-class homes, where there may be more drive or pressure to succeed, and where students with the ability to succeed but had not previously done so were required to take algebra in stride and to master it.

As indicated on Figure 4, the range between the predictive efficiency of the six predictive test scores is smaller

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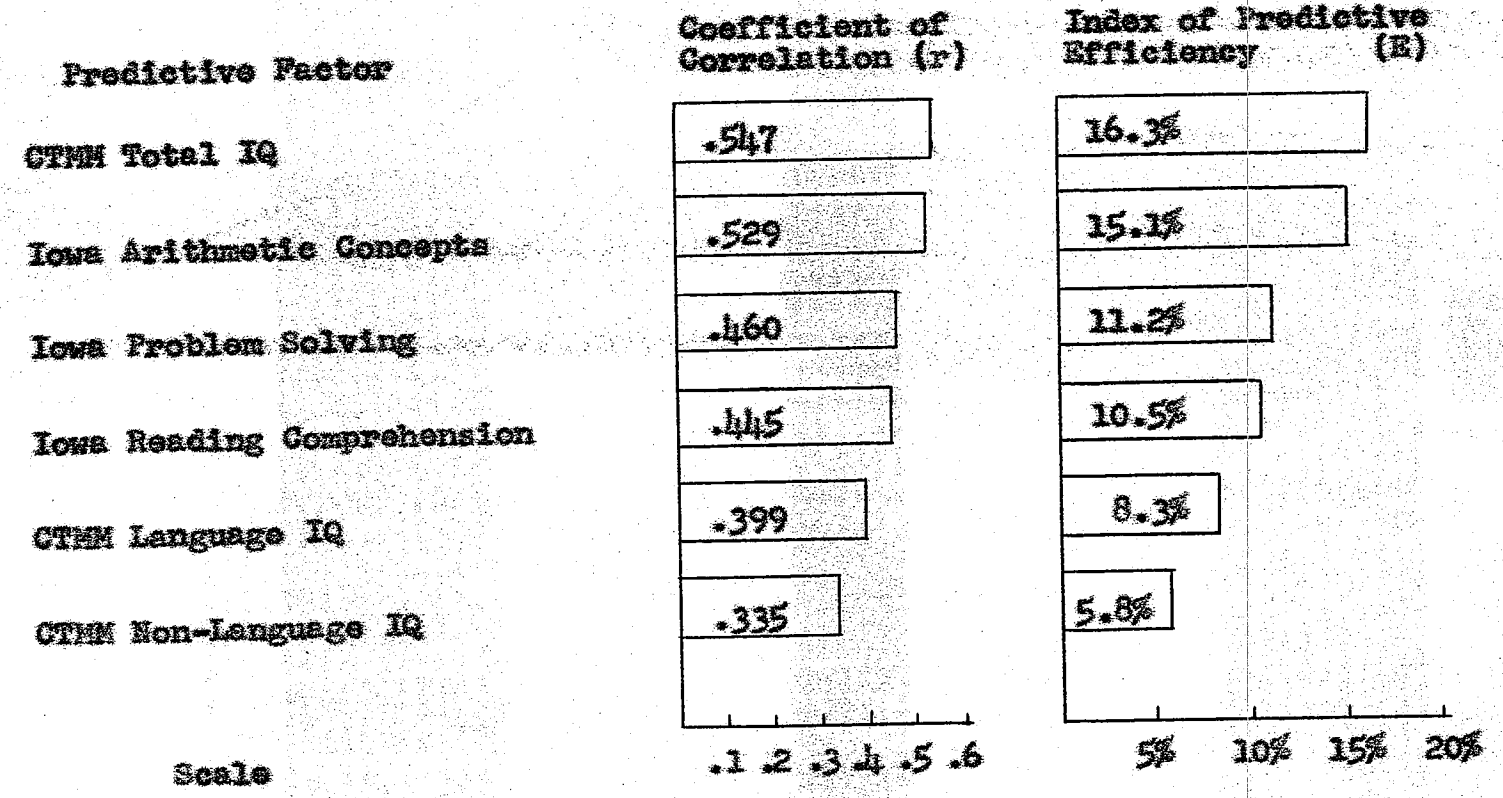
[2]See Appendix, pp. 59, 60.

at Webster than at any of the other junior high schools. The scattergrams show that there is a well-defined pattern of correlation, but that there tends to be more dispersal in algebra achievement for any given score of the predictive items than was true at the other schools.

Stockton Unified School District Results. When the composite picture of all the 422 students in the district for whom results were available was considered, the two top-ranking predictive tests were CTMM total IQ scores (r = .547, E = 16.3%) and Iowa Arithmetic Concepts scores (r = .529, E = 15.1%), as shown on Figure 5, page 34. The first-ranking predictive item for the district as a whole, CTMM total IQ, was not first in any school in the study; its rank order in the four schools was one second, one third, one fourth, and one fifth. The second-ranking predictive test for the district as a whole was, as previously noted, top-ranking predictive item in three of the schools, but the fourth-ranking item at Webster.

The validity of the cumulative SUSD scores was insured by making scattergrams of the 422 cases, and they confirm that these two do present the best pattern of correlation. Specifically, both the CTMM language IQ and the CTMM non-language IQ have individuals who are definitely divergent from the dominant array for the district, while the CTMM total IQ has



STOCKTON UNIFIED SCHOOL DISTRICT N = 422

FIGURE 5

COEFFICIENTS OF CORRELATION AND INDEXES OF PREDICTIVE EFFICIENCY BETWEEN VARIOUS PREDICTIVE FACTORS AND LAMKTON ALGEBRA TEST

an array which is more consistent, but with a fairly wide spread from the line of most frequent scores.[3] While the total IQ is the first-ranking predictive item for the district, its two components uncombined are fifth- and sixth-ranking predictive items: the language IQ is fifth, with r = .399 and E = 8.3%; the non-language IQ is sixth, with r = .335 and E = 5.6%.

The scattergram for the total district of the Iowa Arithmetic Concepts also presents a definite and quite consistent pattern of correlation. The cluster of over-achievers at Webster, those whose Lankton Algebra scores were higher than their predictive scores would have indicated, appears in the scattergram for the district with the same deviation from the pattern of expected performance.

As shown in Figure 5, the third- and fourth-ranking predictive scores for the total district rank close to one another, as do the first two and the last two. The third in order is Iowa Problem Solving (r = .460, E = 11.2%), the fourth is Iowa Reading Comprehension (r = .445, E = 10.5%).

Additional Correlations Computed. In order to apply the multiple regression equation and compute how best to combine the top two predictive items, correlations were computed between them. The correlations between the CTMM total IQ scores and the Iowa Arithmetic Concepts scores for each school in the SUSD and for the district as a whole are shown in Table II on page 36.

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[3]See Appendix, pp. 56-58.

TABLE II

COEFFICIENTS OF CORRELATION BETWEEN TWO PREDICTIVE ITEMS, CALIFORNIA TEST OF MENTAL MATURITY TOTAL I.Q. AND IOWA ARITHMETIC CONCEPTS SCORES

School (s)	Coefficients of Correlation
Fremont Junior High School	477
Marshall Junior High School	596
Stockton Junior High School	558
Webster Junior High School	546
All SUSD Junior High Schools	518

An alternate criterion for evaluating success in first-year algebra would have been final grades earned in algebra. The grades were not chosen as evaluative criteria principally because any observed differences might be attributed to differences in grading procedures rather than to differences in algebra achievement, particularly since there were wide differences between schools. Nevertheless, the Pearson coefficients of correlation between the Lankton Algebra Test and the final grades earned by the students were computed and are presented in Table III.

TABLE III

COEFFICIENTS OF CORRELATION BETWEEN TWO CRITERION ITEMS, LANKTON FIRST-YEAR ALGEBRA TEST SCORES AND FINAL GRADES IN FIRST YEAR ALGEBRA

School (s)	Coefficients of Correlation
Fremont Junior High School	.560
Marshall Junior High School	.803
Stockton Junior High School	.697
Webster Junior High School	.595
All SUSD Junior High Schools	.626

CHAPTER V

INTERPRETATION AND USE OF DATA

Nature of Interpretation Desired. The coefficients of correlation resulting from this study were adequate for the purposes of the study. "Even a coefficient of .50 or .60 does not yield a very accurate estimate of y from x. . . . However, coefficients of .40 or .50 may be useful in predicting upper score limits for variable y from low scores of x, or lower score limits for y from high scores of x."[1] It was this establishing of limits with which this study was concerned. It was possible to identify the most likely Lankton Algebra score for a student with a given predictive score, and the limits within which the algebra score would fall in two out of three cases. Wider limits could also be identified, within which the scores would be expected to fall in a larger number of cases.

Since the concern of this study was to distinguish between those who would and those who would not be expected to succeed in elementary algebra, any range above the most likely score would be acceptable. Since 68% of the cases may be expected to fall within one standard deviation of the mean, and half of the remaining 32% will be in the upper range of the

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[1]John Gray Peatman, Descriptive and Sampling Statistics (New York: Harper and Brothers, 1947), p. 462.

normal curve, all but 16%, or five our of six of the cases, may be expected to lie above minus one standard deviation from the mean.[2]

Scores for District as a Whole Used. In identifying the predictive scores most indicative of algebra success, the top ranking scores for the District were used. Into these scores all the smaller samplings from the individual schools were accumulated. The top two predictive items, CTMM total IQ and Iowa Arithmetic Concepts, had very comparable Indexes of Predictive Efficiency, with E scores of 16.3% and 16.1% respectively. Ranking well below them, but close to each other were Iowa Problem Solving (E = 11.2%) and Iowa Reading Comprehension (E = 10.5%). CTMM language IQ, although it was first-ranking predictive score at Webster and second-ranking at Fremont Junior High, ranked fifth for the total SUSD, with E = 8.3%. CTMM non-language IQ ranked sixth not only for the District as a whole, but also for three of the four individual schools.

Multiple Correlation Used. When the multiple correlation was computed between the top two predictive tests and the Lankton Algebra Test as criterion item, a coefficient of correlation (r) of .617 and an index of predictive efficiency

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[2] Ibid., p. 178, ff.

(E) of 21.4% resulted. This was 31% better than the best single predictive item used alone.

Equal Weighting Recommended. An equal weighting of these top two predictive test scores is recommended. The CTMM total IQ score was shown to be slightly more significant than the Iowa Arithmetic Concepts score, so that a weighting of their scores in the ratio of 10 to 9 was indicated by the regression formula.[3] The fact that the Arithmetic Concepts score was the first-ranking predictive score in three of the schools reenforces the practical consideration of the much greater convenience of giving the items equal weighting.

Results Expressed in Stanines. The results of the California Test of Mental Maturity, expressed in IQ, those of the Iowa Tests of Basic Skills, expressed in grade placement, and the Lankton Algebra Test standard scores were also expressed in stanine equivalents. This not only gave a common frame of reference for comparing divergent test score results, but also was consistent with the policy of the Stockton Unified School District of expressing results in stanine units. Stanine equivalents for the Iowa Tests have used the middle of the year eighth-grade pupil norms, since these are the norms that would be used when the test is administered to eighth grade students. The SUSD test results are reporting chronological

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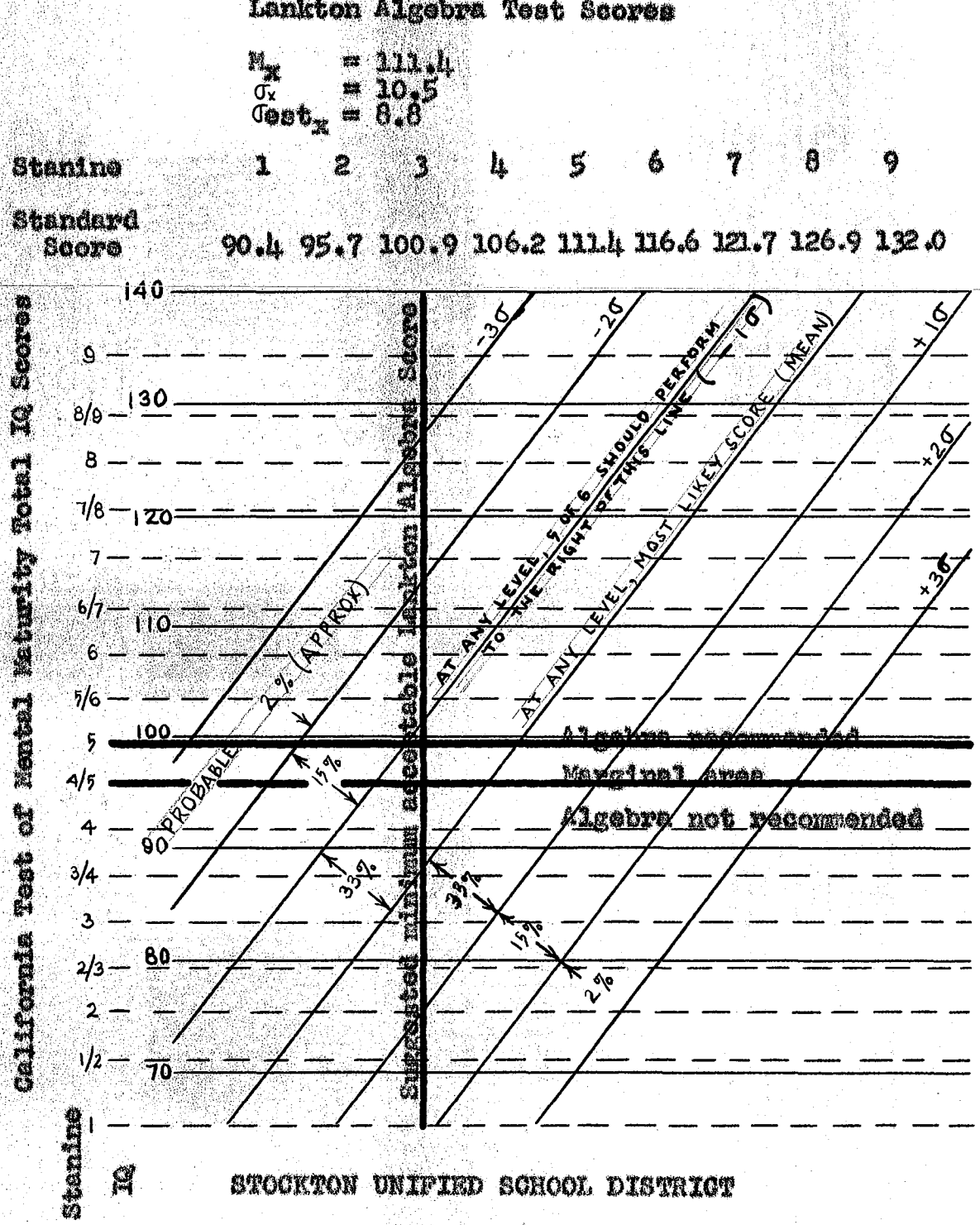
[3] Specifically, $\bar{z}_o = .373\, z_x + .336\, z_y$. See formula, p. 62.

age stanines. These may for practical purposes be interchanged with IQ stanines, except when a child is older than the expected age for his grade.

Charts Indicate Regression Pattern. The pattern by which certain scores in predictive tests anticipate Lankton Algebra Test scores is indicated on Figures 6 and 7, pages 43 and 44. In each figure the score on the predictive test is indicated along the left margin. For any given predictive score the pattern by which algebra success would be anticipated is indicated on the chart at that level. The pattern of expectancy is indicated as a mean score and one, two, and three standard deviations from this score. The regression line indicates the most likely score. Two out of three (66%) of the students may be expected to score within one standard deviation of this most likely score, and eleven out of twelve (92%) may be expected to score within two standard deviations from it. When used for the purpose of discriminating who should and who should not be scheduled to take elementary algebra, five out of six students with any predictive score may be expected to have an algebra achievement score to the right of the line one standard deviation below the mean.

The stanines used for the predictive tests were based on the standardization of the tests. Thus the stanines on the chart would have the same distribution as those to be used in



STOCKTON UNIFIED SCHOOL DISTRICT

FIGURE 6

PATTERN BY WHICH CTMM TOTAL IQ SCORES PREDICT LANKTON ALGEBRA TEST SCORES

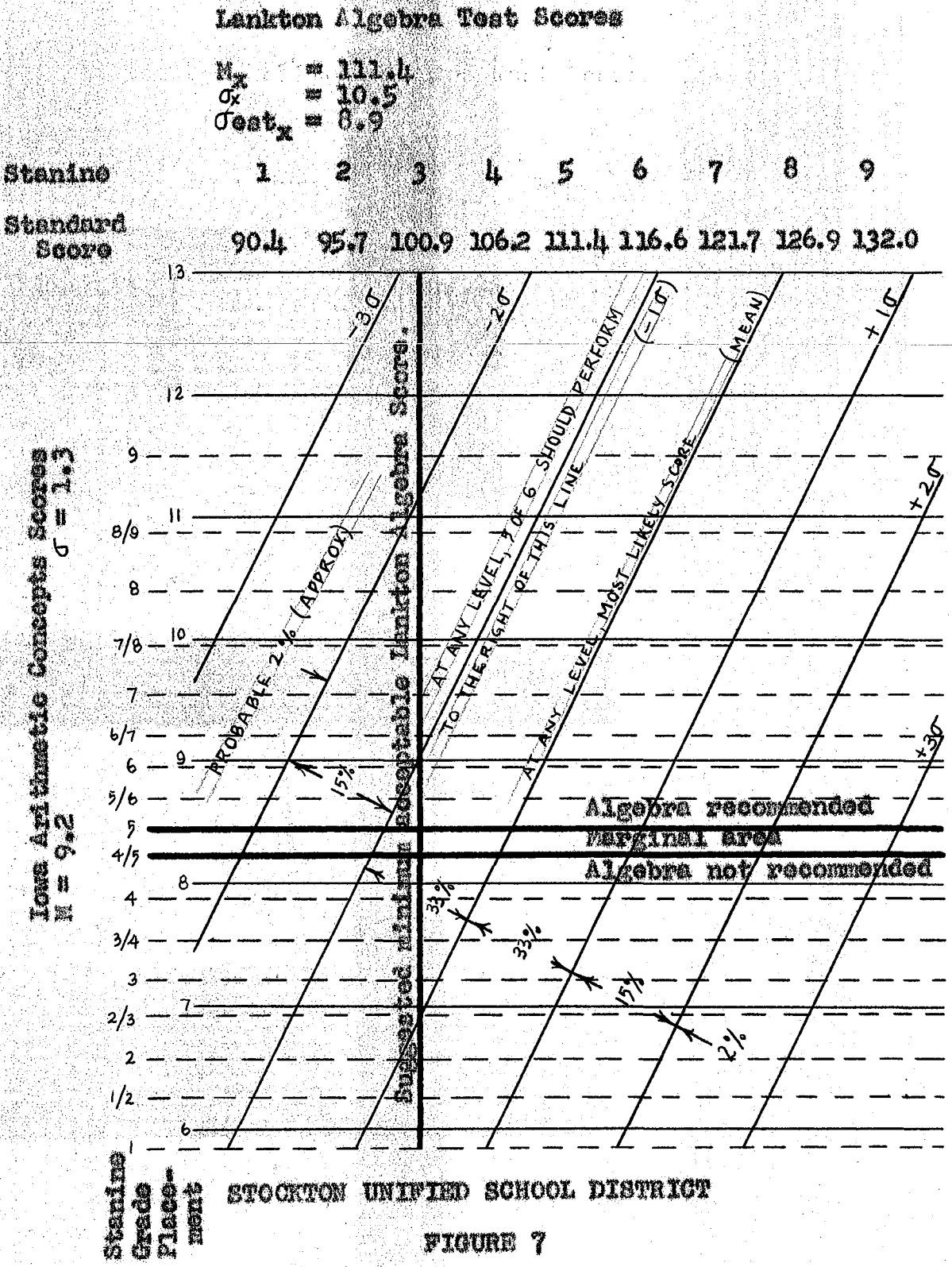


FIGURE 7

PATTERN BY WHICH IOWA ARITHMETIC CONCEPTS SCORES PREDICT LANKTON ALGEBRA TEST SCORES

reporting test results in subsequent years. They were in each case lower than the distribution based on the subjects of this study, since only those students qualified to take algebra were included in the study.

The stanine equivalents of the Lankton Algebra Test were those indicated by this study. The mean score was 111.4 and the standard deviation was 10.5. This was somewhat above the distribution indicated by the publishers of the test; they indicated a mean of 106 and a standard deviation of 12.5.[4] The standardization of this study was based on 422 subjects; the publisher's standardization was based on 3183 students in 57 schools in 22 states.[5] The 422 SUSD students were taken as more normative students in the district in future years than the hypothetical national school population which the test authors were approximating.[6]

Using the standardization of this study, a standard score of 100 is approximately one standard deviation below the mean. Since in stanine meanings, stanines 4, 5, and 6 are average, and stanines 1, 2, and 3 are below average, the division between stanines 3 and 4 would be indicated as a minimum acceptable score. This would give a theoretical 23%

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[4]Robert Lankton, Lankton First-Year Algebra Test Manual of Directions (Chicago: World Book Company, 1951), p. 5.

[5]Ibid., p. 6. [6]Ibid.

of the subjects with unsatisfactory scores.[7] As shown in Table IV, page 47, this would be consistent with the 19.4% of the subjects who actually received grades of D or F in the year of the study. The score between staninos 3 and 4 was 103 in this study, and would be 97 in the published standardization of the test. The recommended acceptable score of 100 not only is an average of these, but it also is on the line between average and low scores on the Lankton Expectancy Chart.[8]

Other Scores Also Helpful. The formulation of this pattern by which success may be anticipated does not remove the necessity for discriminative judgment. The third-, fourth-, and fifth-ranking predictive scores for the District each ranked at least second as a predictive item in at least one of the individual schools. Iowa Problem Solving, Iowa Reading Comprehension, and CTMM language IQ scores should be considered, particularly in those schools where their comparatively high predictive rating is judged to be due to the nature of the student population.

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[7]Walter N. Durost, The Characteristics, Use, and Computation of Staninos (New York: World Book Company, 1959).

[8]Lankton, loc. cit.

TABLE IV

GRADES RECEIVED IN ALGEBRA BY STOCKTON UNIFIED SCHOOL DISTRICT FIRST-YEAR ALGEBRA STUDENTS IN 1958

Grades Received	Fremont Jr. H.S.	Marshall Jr. H.S.	Stockton Jr. H. S.	Webster Jr. H.S.	Stockton Unified School District	
					Number	Per Cent
A	4	10	28	36	78	18.5
B	22	13	38	51	124	29.4
C	25	22	34	57	138	32.7
D	5	11	24	18	59	14.0
F		2	17	4	23	5.4
Totals	56	58	142	166	422	100.0

CHAPTER VI

RECOMMENDATIONS AND CONCLUSIONS

Recommendations for Use. The following recommendations and suggestions are made for using the results of the California Test of Mental Maturity and the Iowa Tests of Basic Skills for evaluating algebra readiness in the Stockton Unified School District:

1. It is recommended that the CTMM total IQ score and the Iowa Arithmetic Concepts score be the two basic items to be considered when deciding which students should be scheduled to take elementary algebra.
2. Assuming the continuation of the policy of scheduling those students to take algebra whose scores indicate their ability and arithmetic achievement to be the equivalent of that expected of an average student in grade eight, it is recommended that students with a stanine score of five in each of these two basic items in grade eight be scheduled to take elementary algebra in grade nine.
3. Recognizing the equal weighting of the two basic predictive test scores, a slight deficiency in one score may be compensated for by a corresponding adequacy in the other. Marginal scores may be computed as half-scores; thus stanine 5/6 may be computed

as stanine 5½.

4. Only if other records of performance, both test scores, grades, and teachers' recommendations, are consistently strong should any student be scheduled to take algebra when the sum of his stanine scores in the two basic items is less than ten.

5. When classes are to be grouped homogeneously, the sum of the staninos of the two basic scores is the recommended basis for selection. Fourteen as a sum of stanine scores of CTMM total IQ and Iowa Arithmetic Concepts tests is suggested as a standard for a class of better than average ability.

6. It is recommended that the Iowa Problem Solving, Iowa Reading Comprehension, and CTMM language IQ scores be available to those charged with the responsibility of discriminating algebra readiness. The interpretation of a deviate score in any of these would depend upon the school, the type of community, and the specific student's background.

7. When used to indicate the readiness of a student in grade seven to take algebra in grade eight, an appreciably higher stanine sum is indicated, both because a good proficiency may be desired for acceleration and because a stanine score relates to

the performance expected at that grade. A stanine sum of fourteen is suggested.

When the primary purpose of administering these tests is for the purpose of algebra prognosis, the year's differential between seventh and eighth grade scores may be overcome by the use of the eighth grade norms for all of the scoring. To obtain a comparable score for students in grade seven and grade eight, the CTMM mental age may be used instead of IQ. When test results are available in terms of grade placement, they indicate comparable achievement.

Recommendations for Further Study. The following recommendations are made for further study:

1. It is recommended that a follow-up study be made of these same students by incorporating into the study their scores in an objective algebra test to be administered at the completion of intermediate algebra. This follow-up study should identify which of the 422 students whose scores were used in this study were attending a Stockton Unified School District high school in 1960, how many of them had taken intermediate algebra, and how their success in intermediate algebra correlated with both their

eighth grade scores and their Lankton First Year Algebra scores.

2. If the follow-up study of these same students in grade eleven confirms that those succeeding in intermediate algebra are largely from those doing best in the eighth grade prognosis tests, ability grouping might be indicated in schools with two or more algebra classes.

Conclusions. This study has indicated that of the scores yielded by the California Test of Mental Maturity and the Iowa Tests of Basic Skills, those most indicative of success in elementary algebra were the CTMM total IQ and the Iowa arithmetic concepts scores. In judging algebra readiness, it is recommended that these tests be weighted equally, and that a student be considered for elementary algebra if the sum of the stanines of these two tests equals ten.

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APPENDIX A

Lankton Algebra Test Standard Score
Mean$_x$ = 111.35 σ_x = 10.49

CTMM Non-Language IQ
Mean = 111.9

	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	f
150											1		1			2
145													2		2	4
140													1			8
135					1			2	1	1	1	1				
130			1		1	1	2	5	2	6	2	3		1		24
125							3	10	7	10	9	2	2			43
120		1	1	2	1	1	13	13	10	11	1		1		1	56
115			1		5	5	18	20	13	8	4	4				78
110		1		1	1	7	9	18	13	7	3	1				61
105	1				1	8	12	18	8	6	2	1				57
100		1		1	1	5	6	12	8	3	1	1				39
95	1			1		1	6	4	1	3	3					30
90				3	2	2	4	1	3							15
85			1		1	2	2	2		3		1				12
80							2	1								3
f	2	3	4	8	14	32	77	106	66	58	27	14	7	1	3	422 (N)

STOCKTON UNIFIED SCHOOL DISTRICT

FIGURE 8

SCATTERGRAM BETWEEN CALIFORNIA TEST OF MENTAL MATURITY NON-LANGUAGE IQ SCORES AS PREDICTIVE VARIABLE AND LANKTON ALGEBRA TEST SCORES AS CRITERION VARIABLE

Lankton Algebra Test Standard Score
$\text{Mean}_x = 111.35$ $\sigma_x = 10.49$

CTMM Language IQ
Mean = 118.1

	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	f
155													1		1	2
150								1		1						2
145								2		3		1				6
140								2	1	2	3	3	1		1	13
135					1	1		1	2	3	2	1	3			14
130						1	1	1	6	7	4	1	2			23
125	1				1	2	7	10	9	10	8	2		1		51
120		1	1		1	3	16	33	18	16	7	4			1	101
115		2	1	1	2	11	20	25	21	12	1	2				98
110	1			3	6	7	20	16	7	3	2					65
105			2	2	2	4	6	8	2	1						27
100					1	2	3	5								11
95						1	2	1								4
90				1												1
85				1			1	1								3
80																
75							1									1
f	2	3	4	8	14	32	77	106	66	58	27	14	7	1	3	422 (N)

STOCKTON UNIFIED SCHOOL DISTRICT

FIGURE 9

SCATTERGRAM BETWEEN CALIFORNIA TESTS OF MENTAL MATURITY LANGUAGE IQ SCORES AS PREDICTIVE VARIABLE AND LANKTON ALGEBRA TEST SCORES AS CRITERION VARIABLE

Lankton Algebra Test Standard Score
Mean_X = 111.35 σ_x = 10.49

Otis Total IQ	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	f
150															1	1
145													1		1	2
140								1		1	2	2	4			10
135								1	3	8	2	1	1			16
130								8	4	7	5	4		1		30
125					3	2	9	18	13	11	8	2			1	67
120			1	1	1	4	14	22	10	19	4	1				77
115	1	3	1	1	3	10	24	22	25	5	3	3				101
110	1		2	1	3	9	14	23	9	5	3	1				71
105				1	3	4	7	6	2	2						25
100				2		2	6	4								14
95				1	1	1	1	1								5
90				1												1
85							1									1
80																
75							1									1
f	2	3	4	8	14	32	77	106	66	58	27	14	7	1	3	422 (N)

FIGURE 10

SCATTERGRAM BETWEEN CALIFORNIA TEST OF MENTAL MATURITY TOTAL IQ SCORES AS PREDICTIVE VARIABLE AND LANKTON ALGEBRA TEST SCORES AS CRITERION VARIABLE

Lankton Algebra Test Standard Score
$\text{Mean}_X = 113.80$ $\sigma_x = 9.27$

Iowa Arithmetic Concepts
Mean = 91.51

	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	f
130																
125												1		1		2
120									1	3	2	2				8
115							1			3	1					5
110							1	1	5		2					9
105						2	4	1	7	3	1					18
100							4	4	4	2						14
95				1	1	6	6	8	2	1						25
90		1			3	4	7	5	6							26
85					1	5	2	7	3		1					19
80					3	2	4	2								11
75				1		2										3
70			2		1	2	1	3	1							10
65					1		1	2	4	1						9
60					1	1	1	1	1							5
55							2									2
f		1	2	2	11	24	34	34	34	13	7	3		1		166 (N)

WEBSTER JUNIOR HIGH SCHOOL

FIGURE 11

SCATTERGRAM OF WEBSTER JUNIOR HIGH SCHOOL BETWEEN IOWA ARITHMETIC CONCEPTS AS PREDICTIVE ITEM AND LANKTON ALGEBRA TEST

Lankton Algebra Test Standard Score
$Mean_x$ = 111.35 σ_x = 10.49

Iowa Arithmetic Concepts
Mean = 9.247

	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	f
130															1	1
125													1		2	3
120										3	4	3	4			14
115								2		1	3	2				8
110								2	2	8	1	3	1	1		18
105						1	3	9	6	12	6	4				41
100						2	3	13	7	6	4	1	1			37
95					1	3	11	18	15	6	5					59
90			2		4	8	18	28	12	11	3					86
85	2		1	3	3	3	20	15	14	5		1				67
80		3	1	1	3	11	14	11	4							48
75				1	2		3	2								8
70				3	1	2	4	2	3	1						16
65						1		1	2	4	1					9
60						1	1	1	1	1						5
55								2								2
f	2	3	4	8	14	32	77	106	66	58	27	14	7	1	3	422 (N)

STOCKTON UNIFIED SCHOOL DISTRICT

FIGURE 12

SCATTERGRAM OF STOCKTON UNIFIED SCHOOL DISTRICT BETWEEN IOWA ARITHMETIC CONCEPTS AS PREDICTIVE ITEM AND LANKTON ALGEBRA TEST

APPENDIX B

FORMULAS USED

A. Pearson Product-Moment Coefficient of Correlation.

$$r = \frac{\Sigma xy/N - dxdy}{\sigma_x \ \sigma_y}$$

B. Coefficient of Alienation.

$$k = \sqrt{1-rxy^2}$$

C. Index of Predictive Efficiency.

$$E = 100\% \ (1-\sqrt{1-rxy^2})$$

D. Standard Error of Estimate.

$$\sigma_{est_x} = \sigma_x\sqrt{1-rxy^2}$$

$$\sigma_{est_y} = \sigma_y\sqrt{1-rxy^2}$$

E. Multiple Regression Equation.

$$\bar{z}_o = \frac{rox-royrxy}{1-r^2xy} z_x + \frac{roy-roxrxy}{1-rxy^2} z_y$$

SYMBOLS

r = Pearson's product-moment correlation coefficient.

Σ = algebraic summation of a series of measures.

f = frequency; number of cases in the interval or group.

x = abscissa of deviations in unit interval terms.

y = ordinate of deviations in unit interval terms.

N = Number of cases in the group of data.

$d_x = \frac{\Sigma fx}{N}$

$d_y = \frac{\Sigma fy}{N}$

$\sigma_x = \sqrt{\frac{\Sigma fx^2}{N} - (dx)^2}$ = standard error; the standard deviation of the sampling distribution.

$\sigma_y = \sqrt{\frac{\Sigma fy^2}{N} - (dy)^2}$ = standard error; the standard deviation of the sampling distribution.

k = coefficient of alienation.

rxy = Pearson's product-moment correlation between variables x and y.

E = Index of predictive efficiency.

σ_{est} = standard error of estimate.

Z = deviations in units of the standard deviation.

rcx, rcy = Pearson's product-moment correlation between criterion variable and variable x or y.